A CALL FOR A TWENTY-FIRST-CENTURY SOLUTION IN OIL SPILL RESPONSE

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Cover photo:

What you see are pristine waters with a white-sand bottom and healthy turtle grass, contributing to a well-balanced ecosystem. But what if that dark area were *crude oil* and your job was to clean it up without damaging the environment; could you do it?

***Because words often have more than one definition,
several words are footnoted as they occur in context.
Additionally, we provide a glossary at the end of this paper.***

First published 2013 by the Lawrence Anthony Earth Organization

ISBN: 978-0-615-75424-6

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14640 Victory Blvd., Suite 208
Van Nuys, CA 91411

This publication is available online at www.TheEarthOrganization.org.

Cover photo: Pristine tropical waters and island.
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Page 3 photos:

Plane spraying chemical dispersant (US Air Force photo, Tech. Sgt. Adrian Cadiz)

Burning oil spill (US Navy photo, Mass Communication Specialist 2nd Class Justin Stumberg)

Oil cleanup responders (photographer unknown)

Failed boom (photographer unknown)

Printed on recycled paper

Written and Compiled by the

Lawrence Anthony EARTH ORGANIZATION

Because None Survive Alone

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Dedicated to the determined and resolute peoples of the Gulf Coast

Acknowledgments

GRATEFUL ACKNOWLEDGMENT GOES TO

All the selfless scientists, environmental groups and their supporters, journalists, and concerned citizens who have donated their effort and expertise to produce and/or make available important studies and information cited in this position paper. These include

Earth Justice
EcoRigs
Gulf Rescue Alliance
Gulf Restoration Network
Louisiana Economic Foundation
Louisiana Environmental Action Network (LEAN)
Natural Resources Defense Council (NRDC)
OSEI Corporation
Public Employees for Environmental Responsibility (PEER)
River Keepers
Senator A. G. Crowe
Strategic Consulting, LLC
Surfrider Foundation
J. A. Turley (author), *The Simple Truth: BP's Macondo Blowout*

as well as national and regional response network members of conscience, and government officials and congressional representatives who have the personal integrity and fortitude to continue to work toward the implementation of better technologies for safer and more effective oil spill cleanup methodology.

We also thank the following people for their professional contributions to this paper:

Rosemary Delderfield, Copyeditor
Editorial & Proofreading Services

Ray McKay, Desktop Publishing
Media City Marketing

Dana Hanson, Research
Government Administration Outsourcing

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Executive Summary

The Science & Technology Advisory Board of the Lawrence Anthony Earth Organization (LAEO) maintains that **the *purpose* of oil/chemical spill cleanup is to remove the pollutants/toxicity from the environment as rapidly as possible so that living organisms can survive.**

Utilizing this principle as a fundamental standard for oil spill cleanup guidance and policy establishes a valuable frame of reference by which one can evaluate response methods—mechanical cleanup, dispersants, and nontoxic agents—as to their effectiveness and economic viability.

Several analyses and summations of the cleanup protocols used during the British Petroleum Deepwater Horizon disaster were not based on the above principle; one being the early 2012 interagency report to Congress,[i] and another, a special feature published in the Proceedings of the National Academy of Sciences (PNAS) journal of December 2012.[ii] The latter report includes an introduction by federal interagency members stating, "*Despite aggressive recovery and removal efforts, only around one-quarter of the oil was removed by the federally directed response.*" In spite of this, the report deemed the cleanup was adequate and arrives at an overall conclusion that indicates similar methodology will likely be used on future spills.

Long-term and even recent studies of oil spill environmental damage and the response methods employed are contrary to these assertions, and instead show that these "successful" methods have failed to remove the toxicity from the environment (and in the case of dispersants, added toxicity), ending up in enormous destruction to wildlife, marine life, the local economy, and human health. These negative results have been well documented during every major spill in recent history, from the *Ixtoc* and *Exxon Valdez* forward.

In light of the above, we are concerned that federal agencies tasked with protecting our waters and natural resources hold the viewpoint that (a) there are no better methods, and (b) the negative effects of chemical dispersants "need more study" before anyone will know for sure, while they continue to use them.

> ***"Despite aggressive recovery and removal efforts, only around one-quarter of the oil was removed by the federally directed response."***
>
> PNAS of December 3, 2012, Perspective: "Science in Support of the *Deepwater Horizon* Response"

If there were no economically viable and effective methods for swiftly achieving close to full removal of oil spills from the environment, then the situation would be dire indeed.

However, the EPA's National Contingency Plan (NCP) currently lists a ***category*** of *nontoxic first-response* oil spill cleanup technology, applicable in all environments, that safely and effectively removes hydrocarbons from a spill site, resulting in full and swift restoration of the environment to pre-spill conditions with no negative environmental "trade-offs."

This position paper addresses how it came to be that a fully developed science-based spill cleanup protocol continues to be overlooked by federal and state regulators and industry professionals despite the fact that it vastly exceeds the results of currently deployed first-response technologies.[iii] This method not only quickly detoxifies and diminishes the adhesive qualities of a spill (and, if need be, detoxifies any deployed dispersants), but its end point is a conversion of close to 100 percent of the toxic spill components to harmless carbon dioxide and water in a matter of a few days to a few weeks.

i. US Interagency Coordinating Committee on Oil Pollution Research [ICCOPR] Report—2012 Biennial Report to Congress.
ii. Proceedings of the National Academy of Sciences (PNAS) Special Feature: "Science in Support of the *Deepwater Horizon* Response."
iii.. See pages 11–19 for details on dispersant-alternative technology.

This guidance material is a constructive offering for every oil-producing country in the world and their potentially contaminated waters, although it utilizes the ongoing BP Deepwater Horizon oil blowout situation in the Gulf of Mexico as a comparative example. While there have been many studies and reports produced about this disaster, our paper brings a new analysis and assessment of the information. It also contains guidelines for the selection process for oil spill cleanup agents, along with an evaluation process that can be used to assess potential effectiveness of those agents in swiftly *removing* spilled oil from the environment.

The effective cleanup of oil-polluted waters is a life-or-death proposition for future generations. An intellectual awakening in both the public and private sectors of the vital importance of preserving our waters brings a demand for nontoxic spill solutions that demonstrate long-term sustainability.

If the agenda is not to just donate the Gulf of Mexico, Niger Delta, Persian Gulf, Alaskan shores, California coast, or other energy production areas to the sole purpose of energy acquisition, then it is time to take bold steps to raise the bar on effective spill response. This means remedies must be employed that will remove closer to 100 percent of the toxicity from the environment so that living organisms, from the tiniest microbes up to the largest mammals, can survive.

LAEO has compiled and released this material in support of all sides and stakeholders, recognizing the importance of supporting the indispensable economic contributions to society that oil and gas companies provide. We know that it is vital, and entirely possible, to simultaneously produce energy and economically protect the environment.

The information we present here is intended to provide a gateway for achieving far higher standards in oil spill response as well as for meeting the compliance criteria of the Clean Water Act.

The LAEO Science & Technology Advisory Board urges all national, regional, and area oil spill response professionals to consider the data we offer herein and to join us in taking a new look at contingency plans and the science on which they are based, to achieve the higher level of oil spill removal standards as set by the Clean Water Act.

Current interagency documents guiding National, Regional, and Area Response Teams in their oil spill response planning are missing considerable information on alternate technologies, specifically *bioremediation* … which resulted in the elimination of a nontoxic first-response bioremediation technology from the response selection process for the BP spill. Liken this to the stigmatization of a star football player left off the playing field based on a biased opinion, not fact. This "first string" exclusion of a viable option for use on the BP oil spill—*NCP-listed Bioremediation Agent Enzyme Additive [EA] Type*—was an unfortunate arbitrary.

Introduction

Traditionally, oil spill cleanup focuses on addressing two problems: 1) how to keep the oil from damaging wildlife, marshes, beaches, waterfronts, and other sensitive habitats; 2) how to reduce toxicity and remove the hydrocarbons from the environment.

Over the past quarter century, oil spill response methodology has mainly consisted of mechanical cleanup, the use of dispersants, and other chemical treatments. The problem is that these "model" approaches are not able to fully remove spilled oil or restore marine environments and other sensitive ecosystems. In general, these methods remove only a fraction of toxic hydrocarbons from an impacted area and, in the case of dispersants, frequently add additional toxicity that adversely affects wildlife and human health.

One of the most difficult decisions that oil spill responders and natural resource managers face during a spill is evaluating the environmental trade-offs when selecting a response method. For example, recent reviews of the decision to use dispersants on the BP Deepwater Horizon oil spill cast doubt on the benefits being greater, as science studies of the response begin to show overwhelming evidence that dispersants cause harm to all life they come in contact with. Part of this decision difficulty is caused by the regulatory guidance itself, which fails to bring forth that within the National Contingency Plan (NCP) there are safer, more effective, and considerably less expensive processes listed that can *remove* toxins from the environment and restore marine habitats and other sensitive ecosystems.

It is the position of our organization that the purpose of cleaning up an oil spill is to swiftly remove the offending toxicity so that even the smallest living organisms can survive—thus ensuring survival for all life forms in the affected area.

Hence, the real problem to be solved is not how do we quickly sink spilled oil below surface waters to protect feathers, fur, marsh grass, and beach; but instead, how do we rapidly remove closer to 100 percent of the toxicity and hydrocarbons of the oil spill from affected waters so that living organisms can survive? Adding dispersants containing neurotoxins and other polluting substances that make the oil 10 to 50 times more toxic is contrary to the basic purpose of cleaning up a spill.

Current Inadequate Spill Cleanup Methods

The Lawrence Anthony Earth Organization (LAEO) recognizes the difficult circumstances and "trade-offs" dilemma the response community faced during the BP oil spill. But we also know there are science-based oil spill cleanup solutions and protocols that, had they been a part of the National Contingency Plan, would have averted a great deal of damage to the ecosystem still in desperate need of relief today. We believe there is a means for bringing about a win-win situation for all sides—environmental interests, business stakeholders, those who rely on the indispensable economic contributions that oil and gas companies provide, and all who cherish their way of life along the Gulf Coast.

One of the missions of our Science & Technology Advisory Board is to clean up the polluted waters of the world by identifying and authenticating effective nontoxic oil spill cleanup technologies; and when found, LAEO works to get these technologies officially designated for use as first-response remedies during spill emergencies and disasters, replacing toxic dispersants and chemicals that have proven to be destructive to all life. LAEO is in agreement with those countries that have taken necessary action to ban and/or restrict dispersants.

While there is an alarming amount of evidence that dispersants do more harm than good, such data brought forth here is not the main purpose of this paper. The intent of this position paper is to offer solutions to the actual problem: The NCP has no guidelines that standardize the assessment process for selecting nontoxic remediation methods for removal of hydrocarbons from the environment without damage to living organisms.

In other words, decision makers who have the authority to act in a spill situation have no plans/guidance in place for any region to support decisions for nontoxic solutions, but rather only a preapproved system using mechanical, burning, and chemical dispersant cleanup methods, which do not remove pollutants from the environment but instead relocate and reposition them. This amounts to having a preapproved system in place that does not get the job done.

LAEO's Science & Technology Advisory Board herein offers a perspective on alternative technologies already contained in the US EPA's National Contingency Plan (NCP) Product Schedule and recommends guidance for assessing and selecting effective, nontoxic solutions.

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We urge all oil spill response professionals to consider the data we present and join us in taking a new look at contingency plans and the science they are based on. Only the willingness to conduct an open and honest review of the facts and end results will serve to move government and industry beyond the current less-than-adequate response plans to the next level of response methodology.

What is at stake?

Future generations' supplies of clean water and food, and sustainable habitats for marine life and wildlife.

The Case against Corexit and Other Dispersants

Serving as an example of the limitations and issues with the current preapproved oil spill response systems, we would like to discuss the recent British Petroleum Deepwater Horizon blowout and oil spill. Reports as of July 20, 2010, indicate that 5 million barrels of oil were released into the Gulf of Mexico, with an unprecedented volume of nearly 2 million gallons of Corexit dispersants applied for mitigation purposes. Despite the fact that chemical dispersants such as these have a stated purpose of protection of shorelines and wildlife by sinking and dispersing the oil below the surface, preventing the oiling of sensitive habitats, feathers, and fur, the mix of Macondo oil and Corexit had mutagenic,[iv] teratogenic,[v] and other harmful effects on the marine food web and is still having such an impact at the time of this writing, nearly three years later.[1] This response method is intended to break the oil into fine particles, making it more easily biodegradable by indigenous oil-metabolizing microbes. That intent, however, is *not* achieved but instead has an end product of preventing biodegradation and causing a gassing off or transference of toxic compounds from water to air, sediment, soil, or other mediums, rendering the "unsightly goo" invisible but, nevertheless, easily detectable and still capable of harming the ecosystem; hence, little oil is in fact removed from the environment. Additionally, with the unprecedented high quantities of chemical dispersants injected at the site of the blowout, 5,000 feet beneath the surface waters, the bioaccumulative and long-term negative effects on the plankton and subsequently all life throughout the food web raise important concerns.[2]

For instance, a Woods Hole Oceanographic Institute study found that dispersants were suspended within an oil-gas-laden plume in the deep ocean and had still not degraded some three months after they were applied.[3] DOSS (dioctyl sodium sulfosuccinate),[vi] a component of Corexit, contributed to this plume, acting as a biocide[vii] and killing the native microbes in the region, effectively retarding the natural biodegradation process.[4] This may account for oil that had sunk but ascended again and was redistributed onto shorelines after storms, such as Hurricane Isaac, triggering a second cleanup effort.[5,6] Official responses to these concerns do not address these problems today any better than they did in the past. Regulators are now calling for more costly long-term studies, stating that "*effects are still uncertain and a better understanding is still needed*."[7] Thirty years of experience with questionable cleanup results from scores of major oil spills that have contributed to the collapse of some fisheries and negative human health impacts should be enough.[8] These impacts have been documented by ample scientific studies from various research facilities, and as a result, we argue that adequate data exists to be able to judge that present modes of spill response are unsatisfactory for the task at hand.[9]

With the unprecedented high quantities of chemical dispersants injected at the site of the blowout, 5,000 feet beneath the surface waters, the bioaccumulative and long-term negative effects on the plankton and subsequently all life throughout the food web raise important concerns.

In short, this independent Science & Technology Advisory Board objects to the current stance asserted by the EPA and NOAA that 25 percent dispersed and burned and

iv. **mutagenic**. Capable of causing or increasing the rate of unnatural mutations in living organisms.
v. **teratogenic**. Capable of causing birth defects and negatively impacting the development of a fetus.
vi. **DOSS (dioctyl sodium sulfosuccinate)**. A toxic surfactant that is a component of Corexit. Common side effects of exposure to DOSS include a breakdown of red blood cell walls and subsequent rectal bleeding, stomach pain, diarrhea, serious allergic reactions, and cramping.
vii. **biocide**. Any toxic chemical that has the potential of destroying life forms by poisoning.

2–8 percent mechanically removed is good enough, "since nature will do the rest." Their statistical reports that claim this measurement of "removal" cannot be verified. This is absolutely an unacceptable cleanup standard.[10] We assert that the only acceptable standard for oil spill cleanup/removal is close to 100 percent remediation accomplished swiftly.[11]

The Gulf of Mexico is one of the world's great hydrocarbon basins and a major contributor to US energy security, delivering a quarter of the country's total oil output. The oil and gas industry in the Gulf is also an important driver of the regional and national economy. As the Gulf expands as an oil-producing region, an increasing proportion of activity and production will take place in ultra-deep waters of 5,000 feet and more.

The Energy Outlook report issued on November 12, 2012, by the US Energy Information Administration (EIA) states that the United States will overtake Saudi Arabia as the world's leading oil producer by about 2017 and will become a net oil exporter by 2030.

Countries all over the world have banned or strictly limited the use of dispersants. For instance, New Zealand and India restrict usage, and in Saudi Arabia environmental policies were established against chemical dispersant usage in their waters because they are wholly dependent upon desalinization for their drinking water.

Today the Gulf of Mexico is a distressed body of water, as evidenced by sores on fish, mutations, heightened chemical and acidic levels, and consequential health issues in humans. It has been known for decades that dispersants cause long-term damage to the entire ecosystem.

With the stepping up of oil and gas production in the United States, the industry is wholly capable of employing safer drilling practices and cleanup solutions. The aftermath of the BP spill and its lessons indicate it is absolutely imperative that new contingency plans be put in place that do not involve the use of dispersants containing toxic compounds, but instead utilize cleanup methods that factually remediate water and soil pollution and predominantly *remove toxins* so that living organisms can survive in a healthy ecosystem.

There is no life without water. The day is coming when clean water will be the new oil, as our vast underground water supply is shrinking. The Ogallala Aquifer—the largest in North America and a major source for agriculture, stretching from Texas to South Dakota—is currently being pumped at a rate 14 times greater than it can be replenished. California predicts, if more supplies are not found, that by 2020 the state will face a shortfall of clean water nearly as great as the amount that all of its cities and towns together are consuming today.

Moving forward in this era of expanded oil production requires a shift in paradigm to more closely align with a standard of *complete removal* of pollutants, which is legally mandated by the Clean Water Act (CWA), enacted over 25 years ago. However, this has apparently been deemed unachievable by regulators and too costly by industry, and as a result, both industry and environmental circles have their time and resources focused on *regulating and studying the effects of dispersants* instead of focusing on bringing forth, field testing, and incorporating new technology that does in fact remove all spilled oil from the marine ecosystem.

Two US federal laws, the Clean Water Act (CWA) and the Endangered Species Act (ESA), contain provisions that specifically ensure that dispersant approval and use will not jeopardize imperiled wildlife and the resources on which it depends. We contend that the preapproval status bestowed upon Corexit,[12] the immediate authorization of its deployment in response to the BP oil spill emergency, and finally, its use being an integral part of nationwide response planning (in which it is staged and ready for deployment in all US waters) are a clear violation of the Clean Water Act in many respects.[13]

Revitalization of the Clean Water Act

The Clean Water Act (CWA) was enacted in 1948 as the Federal Water Pollution Control Act, but the statute was significantly changed and amended in 1972 and became known as the Clean Water Act.

The following is an analysis of how current spill response systems rate against the intent of the law as expressed in the Clean Water Act.

1. The CWA establishes "*it is the national policy that the discharge of* ***toxic pollutants*** *in* ***toxic amounts*** *be* ***prohibited***"[14] [emphasis added].

2. ***Toxic pollutant*** defined: Toxic pollutants, a subset of hazardous substances, include pollutants that "after discharge and upon exposure, ingestion, or inhalation … [by] any organism" will "cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, … or physical deformations in such organisms or their offspring" (33 U.S.C.A. § 1362).[15]

3. **Dispersants** (Corexit 9527, 9500, etc.) **contain toxic pollutants**, which were applied in **toxic amounts** in the Gulf of Mexico, which adversely affected human health and marine life.[16]

4. ***Toxic amounts*** defined: Relative to a multitude of environmental and other factors, "any degree of harmful impacts to any life form by exposure" would be a good working definition for the CWA expression of *toxic amounts*. Prior to May 2010, the EPA had no clear-cut guidelines for the determination of what would constitute "toxic dispersant amounts." Further, the Agency has admitted that long-term effects of dispersants on aquatic life are unknown.[17] In June 2010, in response to public concerns and reports of resultant illness over the use of Corexit dispersants in the Gulf of Mexico, the EPA conducted short-duration tests on an emergency basis to determine the *least toxic* dispersant to use and then issued toxicity threshold levels related to the application of dispersants.[18] Just prior to this, BP had also responded to the EPA's request to find a less toxic dispersant.[19] The public was then reassured by the EPA that the toxicity range of Corexit 9500 recommended by BP fit within the LC 50[viii] toxicity range for aquatic organisms of >10–100 ppm, deemed "slightly toxic" per EPA's "five-step scale of toxicity categories used to classify *pesticides*" (see page 8).

With respect to this criterion, a lower toxicity number indicates a more toxic compound; thus, between 10 and 100 falls within a range considered toxic by the EPA and has raised questions and spawned debate within a variety of scientific institutions conducting research in this area.

We question how nearly 2 million gallons of a dispersant containing 57 chemicals applied on the surface and subsea for a protracted period of time in a broad area could be deemed *not toxic amounts* and *slightly toxic*. Subsequent studies cited by the EPA and NOAA still express a noncommittal position on this point.

Common sense would indicate that when introducing any chemical substance into a freshwater or marine ecosystem that is not native to that environment (for instance, crude oil or hydrocarbon-based dispersants), any toxicity level other than **nontoxic** would be of concern for the health of the local environment, let alone potential impacts on the regional human populations. For example, according to the New Jersey Department of Health, the presence of 2-butoxyethanol (a surfactant ingredient in Corexit 9527 and evident in 9500 per EPA 1999 NCP Notebook) has no *nontoxic* range.[20] The MSDS (Material Safety Data Sheet) states clearly: "*Do not contaminate surface waters* [with this product]."

viii. **LC 50**. *LC* = lethal concentration. *LC 50* is the concentration of a substance that is lethal to 50 percent of the test organisms in a specified time period, typically 48 or 96 hours. (See also page 22, Toxicity Values chart.)

Ecotoxicity Categories for Terrestrial and Aquatic Organisms

Toxicity Category	Avian: Acute Oral Concentration (mg/kg)	Avian: Dietary Concentration (ppm)	Aquatic Organisms: Actue Concentration (ppm)	Wild Mammals: Acute Oral Concentration (mg/kg)	Non-Target Insects: Acute Concentration (pg/bee)
very highly toxic	<10	<50	<0.1	<10	
highly toxic	10-50	50-500	0.1 - 1	10 - 50	<2
moderately toxic	51-500	501-1000	>1 - 10	51 - 500	2 - 11
slightly toxic	501-2000	1001-5000	>10 - 100	501 - 2000	
practically nontoxic	>2000	>5000	>100	>2000	>11

EPA Established Thresholds Five-Step Scale of Toxicity Categories

(EPA toxicity thresholds scale can be found at http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm#Ecotox, and EPA Dispersant Toxicity Testing study at http://www.epa.gov/bpspill/reports/ComparativeToxTest.Final.6.30.10.pdf.)

5. The CWA and subsequent regulations (OPA 90[21] and 40 CFR[22]) call for the design of plans and actions that result in the ***REMOVAL*** of hazardous waste and toxic pollutants from the environment. The EPA is responsible for initiating, managing, and overseeing appropriate *removal* actions.

6. The now obsolete but primary response method of **dispersant** application amounts to **using toxic pollutants to treat toxic pollutants**—a primitive and counterproductive action that increases the toxicity by a factor of 10x or greater.[23] The mechanism of action of chemical dispersants, such as Corexit, is as a detergent. Corexits consist of a class of compounds that have both aqueous/polar and oil/nonpolar functionalities. Detergents provide a solubilizing action, similar to a solvent or soap, to make oil soluble in water. The greatest immediate impact of the use of a chemical dispersant, such as Corexit, is to make the normally insoluble oil (i.e., sheen, slicks, tar balls, etc.) "disappear" by dissolving it in the water column. While the oil contamination is not seen visually by the naked eye, it is nevertheless still present in the environment and can be readily detected by scientific instrumentation. This "solution to pollution by dilution" is inconsistent with the US EPA's policy and regulations for management of environmental contamination. In other words, chemical dispersants render the containment or removal of spilled oil impossible by making (normally) separated oil and tar-like phases totally soluble in water to result in maximum dilution and "dispersion" of the oil. In addition, the detergent action provided by chemical dispersants under high-loading conditions can act as a biocide by disrupting or lysing[ix] the tissues of biological organisms and bacteria that come into contact with these dispersants.

The CWA establishes "*it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited.*" … Prior to May 2010, the EPA had no clear-cut guidelines for the determination of what would constitute "toxic dispersant amounts." Further, the Agency has admitted that long-term effects of dispersants on aquatic life are unknown.

Detergents are commonly used in laboratory and scientific research to disrupt the integrity of or dissolve (lyse) biological cell walls to release cellular contents for use in the laboratory. The effect of cell lysing is to liquefy cell wall membranes, resulting in cell death. Thus, chemical dispersants are not designed to remove oil from the environment; they solubilize/dissolve it and alter the natural biological mechanisms and defenses against toxic chemicals of human and other life forms over scores of years. As covered above, studies have confirmed that oil plus its associated chemical dispersants remain in the

ix. **lyse**. To cause dissolution or destruction of cells by lysins. **lysins**. Antibodies or other agents that cause red blood cells or bacterial cells to break down.

environment/water column for extended periods of time, resulting in adverse impacts on flora and fauna for up to 20 to 30 years, as occurred after the Ixtoc and *Valdez* spills.

7. Moreover, the sole-source preauthorization of dispersants (large stockpiles of Corexits dominate contingency plan staging at the time of this writing) endorsed by the EPA and USCG, to the exclusion of other less toxic products, is an illegal procurement authorization of sole-sourced proprietary products owned by a private company. The US government is required to foster free and open competition of products it uses to implement the CWA. It should be noted that less toxic products have experienced arbitrary regulatory hurdles of such huge proportions that many years of work, including meeting expensive EPA test requirements, have only resulted in closed doors for suppliers/companies ready to deploy these alternatives. Furthermore, this bureaucracy has also made it difficult for federal On-Scene Coordinators (OSCs) to request usage of dispersant alternatives already on the NCP Product Schedule, since these are outside the "long-established system," with no clear-cut protocols.

> **Using toxic pollutants to treat toxic pollutants [is] a primitive and counterproductive action that increases the toxicity by a factor of 10x or greater. … The detergent action provided by chemical dispersants … can act as a biocide by disrupting or lysing the tissues of biological organisms. … The effect of cell lysing is to liquefy cell wall membranes, resulting in cell death.**

The US Interagency Coordinating Committee on Oil Pollution 2010–2011 Research Report, 2012 Biennial Report to Congress,[24] stated: "*Some use the BP Deepwater Horizon oil spill response to suggest that oil spill technology has not changed since* Exxon Valdez*; however, a closer examination … suggests otherwise.*" The report defends and asserts that the BP Macondo spill response was successful using "*effective techniques*" and "*science-based decision protocols.*" While many aspects of this response represented a mammoth feat and genuinely sincere efforts by many competent people, there are a large number of professionals, scientists, and industry leaders who have observed the Deepwater Horizon science-based cleanup protocols and their aftermath as resulting in enormous damage to the seabed, marine life, fisheries, wildlife, and the public's health and area livelihoods, which mandates major changes in methodology. At minimum, the wide chasm in differing views suggests contrary facts that require independent investigation and reconciliation.

To their credit, the plans expressed in the ICCOPR Report to Congress also emphasized: "*The Interagency Committee is committed to expanding our knowledge and tools to meet future oil spill response challenges.*" We welcome that open invitation and are committed to providing expanded knowledge, working in tandem with this national committee.

8. The CWA was weakened in 2006 by two Supreme Court decisions (2001 and 2006), which established precedents resulting in reduced enforcement of the law. The EPA and the Army Corps of Engineers, as a result of these court decisions, changed their policies and abandoned more than 500 Clean Water Act cases being pursued, which cast doubt on how to assess what bodies of water might fall under CWA protections. (See cleanwateraction.org article "How the Clean Water Act Was Weakened" at http://cleanwateraction.org/mediakit/overview-clean-water-restoration-act-2009.)

Oil spills may result in only temporary disruption to the company and industries that cause them, but they are permanent injuries for the rest of us. The purpose of the Clean

Water Act is to protect us and future generations from irresponsible actions that do not take into account the long-term impacts.

It is ironic that the penalties for an oil spill are partially calculated by counts. How many dead turtles? How many square miles of oil sheen? We, at LAEO, encourage open discussion with industry and regulatory agencies to review how the costs of recovery are calculated (the penalty). Penalties based on "*quantity visually gone*" encourage practices like the use of dispersants rather than incentivizing nontoxic solutions that completely remove the oil and all its toxic compounds.

The preapproval status bestowed upon Corexit, the immediate authorization of its deployment in response to the BP oil spill emergency, and finally, its use being an integral part of nationwide response planning (in which it is staged and ready for deployment in all US waters) are a clear violation of the Clean Water Act in many respects.

In light of the above, a restoration and revitalization of the Clean Water Act is in order.

A Star Player on the Sidelines: How (Mis)Guidance Closed the Door

After reviewing and grading the interagency response to the BP DWH oil spill, the National Oil Spill Commission,[25] along with the Government Accountability Office and EPA's Inspector General,[26] has expressed a priority to modify the National Contingency Plan (NCP)[27] in light of Deepwater Horizon lessons learned.

The LAEO has conducted an analysis of existing agency guidance currently in use by the response community. This analysis revealed that current interagency documents guiding National, Regional, and Area Response Teams in their oil spill response planning are missing considerable information on alternate technologies, specifically *bioremediation*.

For instance, the National Response Team (NRT) Science and Technology Committee Bioremediation Fact Sheet of May 2000 (a pivotal guidance paper issued for federal On-Scene Coordinators and Regional and Area response officials and professionals) has not been updated since 2001, despite substantial progress made in this field.[28] This guidance document describes bioremediation processes incorrectly by misclassifying the different agent types and their modes of action as being identical, when one of the three categories has entirely different application principles and natural processes. Thus, going into the BP blowout disaster, we had a misidentification that grouped an entirely different type of agent with bioremediation products classified as "final-stage cleanup" agents, which resulted in the elimination of a nontoxic first-response bioremediation technology from the response selection process for the BP spill. Liken this to the stigmatization of a star football player left off the playing field based on a biased opinion, not fact. This "first string" exclusion of a viable option for use on the BP oil spill—*NCP-listed Bioremediation Agent Enzyme*[x] *Additive [EA] Type*—was an unfortunate arbitrary that has been in place for 23 years.

In hindsight, the consequences of inadequate and out-of-date guidance of this sort were very significant, as decision makers in the EPA and Coast Guard were basing their decisions on outdated information in their manuals, which in fact contain language discouraging the use of any such product as a first-response method for a spill on open water.

So herein lies the problem: When this viable nontoxic alternative to dispersants was presented to the OSCs and other stakeholders charged with selecting the first-string response during the BP oil spill emergency, they kept it out of the game.

Further, this out-of-date NCP Bioremediation Guidance has filtered down and been incorporated into NOAA, Coast Guard, and all Regional and Area Response Team guidance, procedural, and training materials. This has consequently set an erroneous "science-based" precedent, in that all three bioremediation agent categories are mistakenly described as "finishing-up products,"[xi] with limited and restrictive use after a spill has been treated with dispersants and/or otherwise contained. Admittedly, two of the bioremediation cleanup agent categories on the NCP Product Schedule are inappropriate for first-response application in open water; however, category

x. **enzyme**. A biological molecule that increases the rate of chemical reactions. Enzymes are responsible for the thousands of chemical interconversions that sustain life.

xi. **finishing-up product**. A term used to describe oil spill cleanup products that cannot successfully address fresh oil because of the oil's high level of toxicity.

EA, on the other hand, is a nontoxic first-response enzyme-based method containing no live bacteria, with a mode of action that swiftly detoxifies the oil and then removes close to 100 percent of the pollutants from the environment.

So herein lies the problem: When this viable nontoxic alternative to dispersants was presented to the OSCs and other stakeholders charged with selecting the first-string response during the BP oil spill emergency, they kept it out of the game; and even when it was field tested and requested by numerous state officials, the error in classification caused confusion, keeping this star player off the field.

This publication sets forth the full text of the corrected guidance that would have put a viable nontoxic remediation technology solution on the table. (See pages 14–19.)

Bioremediation Agents, Common Misconceptions

BIOREMEDIATION is defined as *the use of microorganism metabolism to remove pollutants*. This is a technology that harnesses the natural character and action of certain beneficial microorganisms to return toxic sites to their pre-spill condition. This technique has existed and been utilized in Superfund land cleanups for decades. Those agents that support the natural process of the microorganisms *indigenous*[xii] to the environment where the spill has taken place have the best record.

One of the broad concerns with bioremediation products is that many contain foreign microbiological cultures and/or nutrients that increase the growth rate of the microorganism population to unnatural levels. Most countries do not allow products with foreign species or microbes in them to be introduced into their ecosystems due to unpredictable interactions and side effects that may occur and/or develop over time that would be detrimental to maintaining the delicate balance in these environments.

A pertinent example of this would be the cane toads that were brought from Hawaii to Australia in 1935 in an effort to control the native cane beetle destroying their sugar cane crops. The toads, being nonindigenous (not native to that region), adopted another food source, became a dominant in the environment anyway, but failed to control the beetle populations. The same is true for mongooses that were introduced to St. Croix, USVI, in the 1880s to control rat populations. Instead of doing this, they adopted ground-nesting birds and snakes as their key prey, significantly depressing those populations, and they themselves became dominant in the terrestrial community, having no impact on the rats. Hence, most oil spill cleanup bioremediation products have been placed in the same category as these ill-conceived introductions and have mistakenly been positioned with scary "bio-monster" connotations. Some feel that these organisms could potentially alter and adversely affect the natural biodiversity when newly introduced into marine environments and coastal areas.

NCP-listed Bioremediation Agent EA Type, however, is a very different bioremediation process than what is generally defined and understood in the industry and contains no microbes.

The toads in Australia and the mongooses in St. Croix serve as good examples of why we should guard against the intrusion of nonindigenous species so that future problems can be prevented.

xii. **indigenous**. A description of a living organism (plant or animal) that is native to a specific geographical region.

NCP-listed Bioremediation Agent EA Type, however, is a very different bioremediation process than what is generally defined and understood in the industry and contains no microbes. It is therefore important to understand precisely what this technique is.

As a first-response alternative that complies with the Clean Water Act by removing the oil rather than dispersing it and increasing toxicity, the 'EA' category has already been carefully considered, extensively tested, and scientifically proven, and as such should be immediately preapproved as a primary method of first response.

Recently the US EPA Regional Response Team VI (RRT VI), which, along with RRT IV, oversees spill response plans in the Gulf of Mexico region, sent a request to their Science and Technology Committee to evaluate Oil Spill Eater II (OSE II), a first-response bioremediation agent (EA Type). The product being nontoxic to marine species, wildlife, and responders has been in use for 23 years on over 23,600 spill cleanups in the United States and in numerous other countries.

As part of this review, the OSEI Corporation CEO (S. Pedigo) lent his expertise to the EPA's RRT VI Science Committee as a member of their Bioremediation Guidance Review Subcommittee. The purpose of the subcommittee was to assist the RRT VI to update the Bioremediation Guidance for the NCP, the last review of which was done in 2001. What resulted was the discovery of important omissions in the EPA guidance documents, which contain no mode of action or proper definitions for the three main types of bioremediation: 1) microbiological cultures, 2) nutrient additives, and 3) enzyme additives. Subsequently, new guidance was compiled and submitted for federal and state interagency response network use.

To ensure this vital information is available, we have inserted the updated guidance, as proposed, in this position paper.

We strongly recommend this document be added to the National Response Team (NRT) and Regional Response Teams (RRT) IV and VI Bioremediation Guidance for the National Contingency Plan (NCP), as well as to Regional Contingency Plans (RCP) and Area Contingency Plans (ACP).

We are pleased to present *BIOREMEDIATION TECHNIQUES, CATEGORY DEFINITIONS, AND MODES OF ACTION IN MARINE AND FRESHWATER ENVIRONMENTS*, herein published for all industry stakeholders: oil companies, responsible parties, the Coast Guard, and state and local responders. For those engaged in the development of safer oil spill response plans, who are looking to minimize natural resource ruin while greatly reducing the cost of oil spill response, this newly updated guidance paper will likely provide welcome answers and solutions.

Important Note: The Lawrence Anthony Earth Organization has no financial ties of any kind to, nor does it receive any financial benefit from, companies that manufacture and/or sell the bioremediation oil cleanup products we advocate. As clearly covered throughout this position paper, our interest is purely to bring this information forth for education purposes and open up a global conversation to the result of implementing greatly improved spill response methodology.

BIOREMEDIATION TECHNIQUES, CATEGORY DEFINITIONS, AND MODES OF ACTION IN MARINE AND FRESHWATER ENVIRONMENTS

(Originally compiled to update and revise RRT IV Spill Response Guidance, *Types of Bioremediation* section and *Bioremediation Response Plan Appendix D*, in coordination with RRT VI and their Science and Technology Committee, who called for revisions in this material.)[1]

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The purpose of this article is to update and supplement the National Response Team (NRT) Science and Technology Committee's *Bioremediation in Oil Spill Response Fact Sheet* published in May 2000 and RRT Guidance documents issued for OSCs and response professionals. Although existing NRT and RRT guidance covers important facts about bioremediation, existing material does not adequately define and differentiate between the three primary types of bioremediation categories listed on the NCP Product Schedule and their associated modes of action. This is important because their respective efficacies require precise application parameters, which vary between target environments. While the limitations and decision points related to bioremediation usage have been covered extensively in previously issued materials, this information is provided to simplify the OSC decision-making process when presented with the three primary bioremediation categories as options.

Essential facts stated in the *May 2000 NRT SCIENCE AND TECHNOLOGY COMMITTEE Fact Sheet: Bioremediation in Oil Spill Response*

"Several factors influence the success of bioremediation, the most important being the type of bacteria present at the site, the physical and chemical characteristics of the oil, and the oil surface area….

"Effective bioremediation requires that

1) nutrients remain in contact with the oiled material, and

2) nutrient concentrations are sufficient to support the maximal growth rate of the oil-degrading bacteria throughout the cleanup operation."[2]

NCP PRODUCT TYPES LISTED

The Bioremediation Agent Types listed on the NCP Product Schedule are designated as follows:

Microbiological Cultures	(MC)
Nutrient Additives	(NA)
Enzyme Additives	(EA)

The first type (MC) constitutes a bioremediation process that utilizes nonindigenous (foreign) bacteria. While useful in controlled environments, a prevailing concern with these types of products has been that the introduction of foreign species might cause future problems that may not become apparent for some time. The second type (NA) comprises those agents that contain nutrients or

1. Submitted to RRT VI Science and Technology Committee in August 2012. Although the chair of the committee stated that key portions of this paper would be integrated into the revised guidance, as of the date of this position paper, that has not yet taken place. While facts about MC and NA Bioremediation Types have been covered in these NRT and RRT Fact Sheets, these materials completely omit any information and important facts on the NCP-listed EA Bioremediation Category and its mode of action, which are critical to accurate decision making using science-based protocols.

2. Bioremediation (Types MC and NA) for open-water spills is not considered to be appropriate or achievable because of the above two requirements. When nutrients are added to a floating slick, they immediately disperse into the water column, being diluted to near-background levels (with the exception of NCP-listed Type EA, based on extensive field use and testing on fresh and weathered hydrocarbons/oil, which recently demonstrated an 80 percent rate of PAH degradation on Macondo Block, La., sweet crude containing Corexit, per BP Biochem Strike Team leader D. Tsao, LSU R. J. Portier, and L. M. Basirico, *Laboratory Screening of Commercial Bioremediation Agents for the Deepwater Horizon Spill Response*, March 3, 2011).

fertilizers to support the microorganisms present in the spill environment. Both have been designated as not applicable to open-water environments. See 2001 EPA Guidance *Guidelines for the Bioremediation of Marine Shorelines and Freshwater Wetlands*, which extensively covers the usage of these two product types, so need not be repeated here.

On the other hand, the third type (EA) is appropriate as a first-response tool in open-water environments. Bioremediation EA Type has evolved in recent years and has been the subject of considerable technological advances, with wide applicability for oil spill response in fresh, brackish, and marine environments, under temperature conditions as low as 28°F. The mode of action of this type will be reviewed in detail here.

CONTEXT

The primary reason for cleaning up oil spills is to reduce or eliminate the toxic components, thus enabling the survival of fauna and flora, including single-cell organisms, in each niche of the food chain. Although dispersants commonly used today eliminate the visual and other damaging aspects of the spill on the surface, the spill's toxicity problem remains in the environment and at times is worsened by the adding of hydrocarbons contained in dispersants. The goal of the bioremediation process is to convert oil/hydrocarbon-based material to CO_2 and water, thereby permanently removing oil/hydrocarbons from the environment and returning the affected spill area to pre-spill conditions.

Herewith, the three main types of bioremediation are further defined, along with their modes of action, to help federal On-Scene Coordinators (OSCs) and federal, state, and local officials, as well as responsible parties, to understand, and make more informed decisions about, bioremediation agents when selecting oil spill response tools.

CATEGORY TYPE ENZYME ADDITIVE (EA)

Although the NRT and RRT guidance documentation addresses the MC and NA bioremediation types in the 2001 *Guidelines for the Bioremediation of Marine Shorelines and Freshwater Wetlands,*[3] they do not sufficiently detail the mode of action of *Bioremediation Type EA*.[4] This may be described as follows.

ENZYMATIC AGENT (EA) DEFINITION

Enzymatic agents are biocatalysts that are designed to enhance the emulsification and/or solubilization of oil to make it more available to microorganisms as a source of food or energy. These agents are generally liquid concentrates, which may be mixed with surfactants and nutrients manufactured through fermentation. This type of agent is intended to enhance biodegradation by indigenous microorganisms.

EA TYPE MODE OF ACTION

Enzyme Additive mode of action is applicable to open/moving water (fresh, salt, and brackish), marsh/estuaries, shoreline, and soil environments. When applied, the nontoxic converters and biosurfactants in Bioremediation Agent EA Type eliminate the classic appearance of an oil spill by emulsifying and solubilizing the molecular hydrocarbon structure and eliminating the adhesion properties of crude oil. This usually takes place within the first 5 to 30 minutes (depending upon temperature). The emulsified oil continues to float near the surface, thereby eliminating a secondary impact to the water column and seabed.

With the toxicity and adhesion properties eliminated, wildlife that may come in contact with the broken-down hydrocarbons will not become coated in oil, and oil adherence to marsh, shorelines, sands, and man-made structures is greatly reduced. Flammability is eliminated

3. 2001 Guidelines for the Bioremediation of Marine Shorelines and Freshwater Wetlands, http://www.epa.gov/osweroe1/docs/oil/edu/bioremed.pdf.
4. As of this date, there is only one product on the NCP list that falls under this Bioremediation Agent Type EA classification: B-53—EA—OIL SPILL EATER II; thus, descriptions above regarding the mode of EA interaction at this time are related solely to this EA product. Any newly added EA Type listings would require review and validation for being categorized here.

rapidly (again, depending upon temperature), helping to protect ports, harbors, and oil/gas platforms from potential explosion hazards associated with fuel spills.

A further action of bioremediation category EA is that its numerous enzymes then attach themselves to hydrocarbons with the biosurfactants, developing protein-binding sites. These sites act as a catalyst to accelerate the bioremediation process by inducing enhanced indigenous bacteria to utilize the detoxified oil/hydrocarbons as a food source. The EA category also contains properties that cause all the constituents to remain in contact with the spilled oil/hydrocarbons in moving waters.

Over ensuing days or weeks (again, depending on temperature), nontoxic nutrients in the Enzyme Additive Type rapidly facilitate an increase in indigenous bacterial populations. The bacteria consume the detoxified hydrocarbon emulsion, digesting the oil and reducing it to CO_2 and water—permanently removing the oil/hydrocarbons from the environment—resulting in final water clarification. Without category EA assistance, this natural process may take up to 20 years, based on the Ixtoc and *Valdez* spill studies.

SHORELINES / MARSHES

When a spill makes landfall or contaminates a marsh, category EA can be safely applied to lift the spill off the marsh grass (or sandy beaches or shorelines), limiting the time required for the oil to adversely impact these areas. The use of category EA does not deplete O_2 from water, since the oil is buoyant and the enzymes use atmospheric O_2 for their biochemical interactions.

There are no known trade-offs, deleterious effects, or collateral damage associated with the EA method.

There is no limited window of opportunity for the application of category EA; it can be used in estuaries, open marine (salt) waters, moving freshwater bodies such as rivers, and in soil. It is effective as a first-response tool and/or when applied days or months after a spill. Category EA can also be applied to oil accumulated on the seafloor, eventually lifting it to the surface and returning the seabed to pre-spill conditions.

CATEGORY TYPE MICROBIOLOGICAL CULTURE ADDITIVE (MC)

As covered in NRT Science and Technology Guidance, "… *bioaugmentation*" is the process by which "oil-degrading bacteria are added to supplement the existing microbial population."

DEFINITION

Microbial agents are concentrated cultures of oil-degrading microorganisms grown on a hydrocarbon-containing medium, which have been air- or freeze-dried onto a carrier (e.g., bran, cornstarch, oatmeal). In some cases, the microorganisms may be colonized in bioreactors at the spill site. All commercially available agents use naturally occurring microorganisms. Some agents may also contain nutrients to assure the activity of their microbial cultures. This type of agent is intended to provide a massive inoculum of oil-degrading microbes to the affected area, thereby increasing the oil-degrading population to a level where the spilled oil will be used as a primary source of food for energy. Microbial agents are designed to enhance the biodegradation of oil at any location and would be most useful in areas where the population of indigenous oil degraders is small.

MC TYPE MODE OF ACTION

Bioremediation Agent Type MC mode of action utilizes nonindigenous bacteria with the objective of digesting oil/hydrocarbons to CO_2 and water.

Bioaugmentation is considered a "polishing-up" or "finishing" response product, in that it cannot be applied to fresh oil because the toxicity levels kill the added oil-degrading bacteria.

When nonindigenous bacteria are placed on or near weathered oil, they attempt to release enough quantities of biosurfactants to detoxify the spill so that the oil-degrading bacteria will not be adversely impacted by the spill's toxicity, enabling them to use the hydrocarbons as a food source. The oil-degrading bacteria (both indigenous and nonindigenous) produce enzymes to develop protein-binding sites, which permits the bacteria to convert the molecular structure of the hydrocarbons for use as a food source. This process requires a protracted amount of time.

While bioaugmented bacteria acclimate to the newly available oil, temperature of the environment, pH, and available nutrients, other environmental factors may produce adverse conditions that can forestall the breakdown action. These factors, along with the unknown time frames associated with their acclimation process, are at least partially responsible for the past uncertainty associated with using Bioremediation MC Type as a cleanup methodology.

Nonindigenous bacteria should generally be used where there is very little water movement. Water movement causes the products to become diluted to ineffective levels incapable of staving off natural competition from indigenous bacteria, and thus also incapable of supplying sufficient population numbers to produce enough biosurfactants and enzymes to start the breakdown of the molecular structure of the hydrocarbons. (Laboratory environments do not satisfactorily duplicate this type of competitive environment; hence, particularly in moving waters, the final outcome of treatment is often uncertain.)

Next to the toxicity of the spill, the most difficult aspect of utilizing nonindigenous bacteria in a foreign environment is natural competition from indigenous bacteria already acclimated to the target area. Indigenous bacteria are often competitively superior.

Bioaugmented bacteria developed specifically for fresh water must be used in freshwater settings only. Products containing saltwater bacteria can only be utilized in saltwater. MC Type bioremediation is best used on closed and/or controlled environments and should not be considered effective in open-water environments.

The use of nonindigenous bacteria in most countries is not permitted due to the uncertain effects of introducing them into sensitive environments.

CATEGORY TYPE NUTRIENT ADDITIVE (NA)

As covered in NRT Science and Technology Guidance, this next category (NA)—"*biostimulation*"—is a process "*in which nutrients, or other growth limiting substances, are added to stimulate the growth of indigenous oil degraders*."

DEFINITION

Nutrient Additives are bioremediation agents that contain nitrogen and/or phosphorous as the primary means to enhance the rate of growth of indigenous oil-degrading microorganisms. This type of agent is intended to increase the oil-degrading biomass already present in an affected area to a level where the oil will be used as a primary source of food or energy. Because the natural environment may not have sufficient nutrients to encourage bacterial metabolism and growth, extra nutrients may be required. The purpose of this type of agent, therefore, is to provide the nutrients necessary to maintain or increase microbial activity and the natural biodegradation rate of spilled oil.

NA TYPE MODE OF ACTION

The NA mode of action involves the general use of nutrients or fertilizers that contain various volumes of nitrogen (N) and phosphorus (P). The nutrients are distributed in association with a spill and are expected to enhance the population growth of indigenous bacteria.

These bacteria need time to secrete biosurfactants to attack the molecular structure of the spill by solubilizing the oil/hydrocarbons, emulsifying the spill, and increasing the oil-water interface. This helps to detoxify the hydrocarbons to a point where enriched indigenous bacteria can utilize the spill as a food source.

It can be difficult to apply nutrients or fertilizers to a spill area containing toxic oil and be able to enhance bacterial population growth. Many of the indigenous bacteria are destroyed initially by the toxicity of the oil; and because of the oil's toxicity, the nutrients or fertilizers are usually precluded from augmenting the remaining indigenous bacteria.

Supplying nutrients or fertilizers in concentrations necessary to enhance bacteria while not increasing the nitrogen levels to the point where they become toxic to aquatic life is another key problem. In addition, it is difficult to contain the nutrients or fertilizers in the target area with the oil, especially in moving waters.

The process of enhancing indigenous bacteria with nutrients or fertilizers and waiting for them to secrete biosurfactants and enzymes in order to start the bioremediation process takes a protracted period of time. Again, this makes NA Type inappropriate as a first-response agent.

Bioremediation category NA can be effectively used where there is little tidal flush, and where the oil has weathered so its toxicity is reduced to the point that indigenous bacteria can survive. This requires NA to be used only as a polishing-up agent, with limited scope.

A BRIEF NOTE ON PHYTOREMEDIATION

Phytoremediation is defined as the use of green plants and their associated microorganisms to degrade, contain, or render harmless environmental contaminants.

Phytoremediation of petroleum hydrocarbons generally involves three major mechanisms: (1) degradation, (2) containment, and (3) the transfer of contaminants from the soil to the atmosphere.

For further information on applicability, consult page 87 of http://www.epa.gov/osweroe1/docs/oil/edu/bioremed.pdf.

CLOSING COMMENT

The three types of bioremediation and their modes of action (described above) have been detailed here to help responders understand how these agents will interact with a spill. The diverse types and their modes of action are clearly independent of each other, even though their end point in principle is the same; the ability to reach that end point, and the amount of time it takes to do so, is obviously different.

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Identification of Nontoxic Methods for Contingency Plans

The establishment and enactment of new contingency plans associated with remediation of oil spills (including those response plans submitted by oil companies requesting permits) is urgently needed, using methodologies other than intensive application of chemical dispersants. The commencement and acceleration of new deep-water drilling in the Gulf of Mexico and the Beaufort Sea in Alaska, for instance, particularly in the absence of updated contingency plans in the event of a spill, is quite concerning. In other words, hundreds of permits have been issued since September 2010 with no significant change in spill contingency planning—other than more advanced deep-water dispersant injection systems that have been added to plans, which would produce a repeat of the Deepwater Horizon toxic response.

The information presented here is for distribution to Regional/Area Committees and all stakeholders responsible for maintaining up-to-date contingency plans for safeguarding our aquatic, marine, and terrestrial environments. The article included regarding bioremediation category definitions and their modes of action, along with further information below, should overwrite previous guidance on bioremediation because it clarifies use of the Bioremediation Agent EA Type as a FIRST-RESPONSE agent.

Bioremediation Agent Enzyme Additive Type can clearly serve as a first-response alternative to the use of chemical dispersants, which no longer have a place in modern-day oil spill cleanup in US navigable waters.

NCP-Listed Bioremediation Agent (EA Type) as a Solution and Alternative to Chemical Dispersants

We encourage independent investigation of EA Type as a promising potential solution to oil spill response in deep-water drilling and difficult access environments, particularly as a first-response method for open-water oil spills, in lieu of chemical dispersants of any kind.

It is the position of the Science & Technology Advisory Board of the Lawrence Anthony Earth Organization that Bioremediation Agent Enzyme Additive Type can clearly serve as a first-response alternative to the use of chemical dispersants, which no longer have a place in modern-day oil spill cleanup in US navigable waters.

The EPA is now being pressed to find safer response agents to replace these outdated modes, which, when combined with oil pollutants, are more toxic than the oil itself and therefore contrary to the intent of the US Clean Water Act (CWA).[29] To reiterate, the CWA stipulates that, for a response method to be utilized, it must **REMOVE** oil from the environment. Dispersants do not fulfill this requirement; in fact, studies have shown that use of dispersants prolongs the time that oil plus chemical dispersants remain in the environment, resulting in adverse impacts to flora and fauna for up to five years or longer.[30,31]

The good news is that there are developed protocols for identifying and assessing the degree of usefulness of spill-response products, and they are not complicated.

How Oil Spill Cleanup Products Should Be Assessed and Prioritized

The LAEO has conducted nearly three years of research to find methods for remediating oil spills that are more effective and less toxic than those currently used. We have also been working to gain the necessary authorizations for utilizing these more effective techniques to clean up the waters of the Gulf and its shorelines still impacted by the Macondo spill.

Our first step was to vet the applicable products on the EPA NCP Product Schedule. We developed a set of guidelines by which to review products and determine their eligibility for use in US navigable waters. We were not looking for any given product but merely those that fell under our criteria for desired effectiveness, as follows:

- On the NCP list.
- Swift and effective removal of the oil, not just dispersal of it by solubilizing or dissolving it into the water column.
- Nontoxic with no destructive "trade-offs" associated with its application.
- Able to also detoxify chemical dispersants—e.g., the two types of Corexit that have been broadly used domestically and internationally.
- Using neither nonindigenous microbes nor genetically modified organisms.
- Complete scientific documentation substantiating the product's efficacy.
- A track record of success in the field.
- Pretested and screened as usable anywhere—open water, sandy beaches, marshes, etc., as a first-response method (i.e., predetermined as applicable in all environments to enable rapid response without the need for assessment during an emergency).
- The manufacturer has sufficient quantities in stock and immediate production capabilities to handle a spill of significance.
- Its use and application must be economically reasonable and within acceptable ranges of expected remediation costs.
- Eliminates or significantly reduces the necessity for secondary cleanup, such as cleaning up tar mats formed by sinking the oil using dispersants, disposal of hydrocarbon-based material in landfills, or other methods of disposal.

Our extensive search revealed only one product that fulfilled all of these requirements—one under the Bioremediation subcategory EA on the NCP list: Oil Spill Eater II (OSE II). **We continue to look for other products that fulfill these criteria, but in the meantime, at least there is one bioremediation category that could effectively lead response methods into the twenty-first century**; and as of the writing of this paper, the only product that has been able to meet our guidelines has been OSE II.

LAEO produced a documentary film to educate the public on bioremediation and to encourage researchers and companies with products that meet the above criteria to step forward.[32] Several products have since been submitted to us for our advocacy, and some, although promoted as "nontoxic," were found to be at least as toxic as crude oil.

New and innovative solutions utilizing all available technology are needed for the situation in the Gulf of Mexico, as well as future hydrocarbon-based spills that will continue to occur in all the waters of the world. If we stay on the same track, we run the risk of having fisheries collapse, a chemically stressed ecosystem worldwide, and progressively worsening human health issues.[33]

Characteristics of an Effective Solution—Feasibility Assessment Criteria

The protection of human health should be the foremost concern of any oil spill cleanup decision-making process. Human health is dependent upon the relative health of the surrounding environment; hence it is important to understand the criteria by which cleanup methods must be gauged as to their value and effectiveness. To reiterate, the primary reason to clean up an oil spill or hazardous materials is to rapidly reduce the impact of their toxicity so that all living organisms can survive. And again, if even the smallest organisms can survive, then the ecosystem will be able to sustain itself.

Thus, our recommended standards for the ideal technology or agent for use in cleaning up a hazardous spill would be these:

1. **Must swiftly** and thoroughly **detoxify** the oil or hazardous substances as a first step in order to protect the indigenous microbial populations and all life forms.

2. **Must nullify** the oil's **adhesive qualities** so that it does not stick to marine life, wildlife, marsh grass, rocky shorelines, sandy beaches, or seabed sediment.

3. **Must keep the oil on the surface** so that it can most rapidly be digested by indigenous microbes, utilizing existing airborne oxygen and protecting the 60 percent of marine life that resides in the subsurface area. (Note: This also makes it accessible for physical removal methods working in tandem with nontoxic agents.)

4. Understanding that nature uses surfactants[xiii] in the natural process of cleaning up an oil spill, an effective product would have **no** *toxic* **surfactants** such as are contained in both Corexit 9527 and 9500. (For instance, Bioremediation EA Type OSE II contains no toxic surfactants and is fully tested and validated as nontoxic. Comparing toxicity levels using established EPA standards cited earlier, Corexit 9500 had a high toxicity level of 0.065 to 0.354 ppm compared to OSE II, which had a reading of 10,000 ppm for one of the most sensitive marine species tested [the higher the number, the lower the toxicity level]. This means that Corexit is as much as 150,000 times more toxic than the bioremediation alternative. See Toxicity Values chart below.)

5. Must have **a scientifically substantiated and predictable end point** that could be standardly achieved from its proper application. This end point would be that within a matter of days to, maximally, a few weeks, close to 100 percent of the oil would have been converted into CO_2 and water—two benign substances—without any adverse side effects, or "trade-offs" related to its application, thereby protecting the responders, wildlife, and marine life.

6. Its application must be **economically viable**—for example, comparable in cost to current methods and, ideally, significantly less.

LC 50 TOXICITY VALUES (Environment Canada Tests)					US EPA Tests	US EPA Tests
Species	Oncorhynchus mykiss	Photobacterium phosphoreum	Gasterosteus aculeatus	Daphnia magna	Menidia (silverside fish)	Mysidopis (shrimp)
Corexit 9500	354 (96hr)	0.065 (highly toxic)	not listed	not listed	25.2 (96hr)	32.23 (48hr)
Corexit 9527	108 (96hr)		103 (96 hr)	42 (48 hr)	14.57 (96hr)	24.14 (48hr)
OSE II	10,000 (96 hr)	5109 (IC 50) (30 mins)		10,000 (48hr)	8839 (96hr)	6698 (48hr)

LC 50 = Lethal concentration values in parts per million measuring level in which there is mortality with 50 percent of species being tested over a specific period of time. Higher # = less toxic, lower # = greater toxicity in ppm.

Sample Toxicity Comparison, Environment Canada and US EPA Tests, Bioremediation vs. Corexits[34]

xiii. **surfactant**. A substance that lowers the surface tension of water, making it easier for organic compounds to be dissolved in the water. There are toxic and nontoxic surfactants; i.e., chemical based with various degrees of toxicity, and plant/living-organism based = nontoxic.

Our research found that an EA Type bioremediation technology that meets the above criteria exists today and is being used in over 30 countries. Its results contrast strongly with those derived from dispersants predominantly used in US navigable waters. Additionally, it costs a fraction of the other methods and would therefore represent an economic boon, not only to the responsible parties, who could avoid damage claims and heavy fines, but also to those living in the environment, reducing business disruptions with rapid cleanup, bringing a quick return to their livelihoods. In other words, in addition to preserving the health and safety of the waters, there would be little impact on tourism, coastal businesses, and fisheries.

The value of a product could be rated and characterized by how rapidly and thoroughly it meets the above criteria while introducing no additional toxicity to the scene already created by the hazardous spill.

Due to the many common misconceptions about bioremediation, and especially the subcategory EA Type on the NCP list, LAEO's Science & Technology Advisory Board has provided the above summary of our vetting process of spill-response methods for use by all interested parties.

We encourage independent investigation of EA Type as a promising potential solution to oil spill response in deep-water drilling and difficult access environments, particularly as a first-response method for open-water oil spills, in lieu of chemical dispersants of any kind. … To reiterate, the primary reason to clean up an oil spill or hazardous materials is to rapidly reduce the impact of their toxicity so that all living organisms can survive. And again, if even the smallest organisms can survive, then the ecosystem will be able to sustain itself.

Challenging Current Methods and Rethinking Oil Spill Response

Being willing to challenge and debate brings different views into the open to improve outcomes. To recap, as of the date of this writing, more than 150 permits for offshore drilling activities have been approved since the BP Deepwater Horizon spill; yet response contingency plans have not changed and continue to depend upon outmoded toxic dispersants and other methods such as *in situ* burning as the main address to potential spills. To the Department of Interior's credit, this agency recently conducted independent comparative testing between dispersants and the NCP-listed bioremediation agent Oil Spill Eater II, finding it removed 67 percent of heavy oil in 30 days, while the dispersants demonstrated no removal capabilities at all. And in 2012, Regional Response Team VII conducted similar tests demonstrating a 100 percent removal capability of this EA Type agent.[35]

According to the Operational Science Advisory Team report initiated by the US Coast Guard, natural petroleum seeps release more than 17 million gallons (404,750 barrels) of oil into the Gulf of Mexico annually. Comparatively, the BP Deepwater Horizon oil spill released more than 211 million gallons (4.93 million barrels) over the first 87 days. Their statement that "an estimated 25 percent of this volume was burned or collected, leaving the remainder available for natural attenuation or collection along shorelines" appears to lightly regard the significant remainder of oil that has been left in the Gulf to do ongoing harm. Many scientists and experienced responders estimate that a far smaller percentage of the oil that was released into the Gulf has actually been removed from the environment. Assuming the official figures are correct—that 25 percent was burned or collected—this would still leave 1 million barrels (42 million gallons) of oil as a conservative assessment. Going by the USCG estimate, if 75 percent were left to natural attenuation, this would represent an area one inch thick covering 83 square miles. And given the fractured and faulted condition of the seabed floor around Macondo Block 252, it is expected oil will continue releasing from this site for up to 10 years or more.

More than 150 permits for offshore drilling activities have been approved since the BP Deepwater Horizon spill; yet response contingency plans have not changed and continue to depend upon outmoded toxic dispersants …

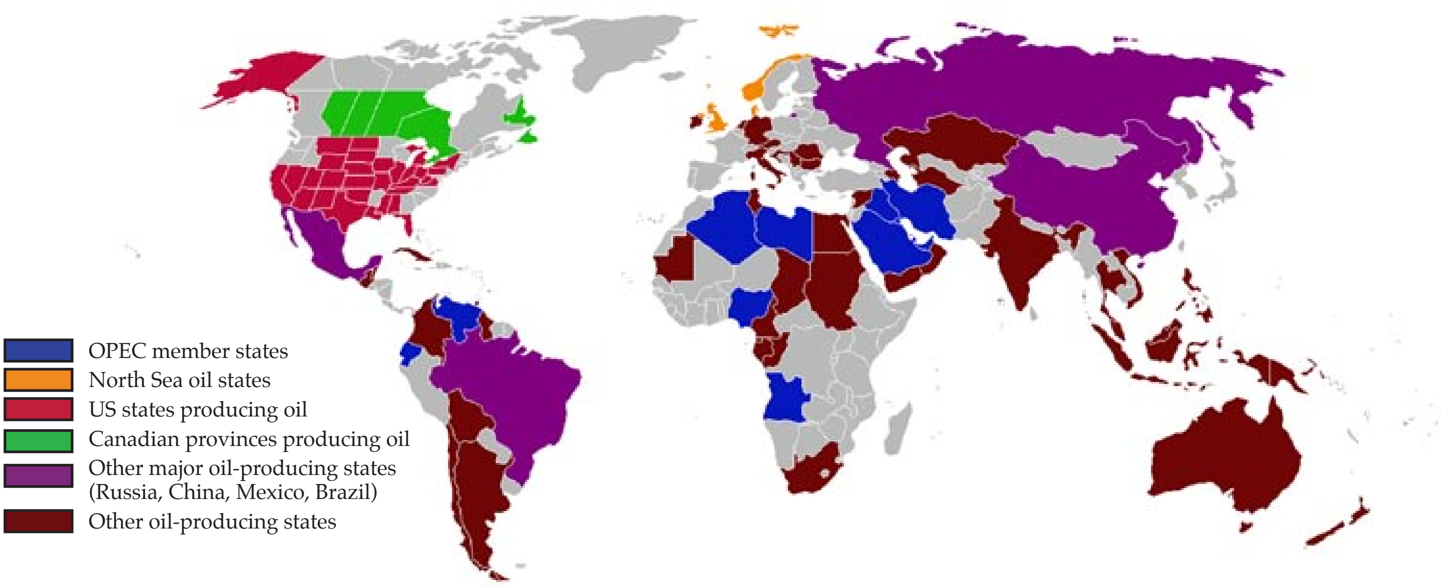
The Coast Guard study arrives at this final conclusion: *"The degree and rate of weathering of Deepwater Horizon oil is still uncertain. Better understanding of the degradation processes of oil in the environment is still needed."*

Proper assessments and protocols need to be developed for each type of Bioremediation Agent as to its suitability in terrestrial, coastal, freshwater, brackish, and marine environments. This will allow the term *bioremediation* and its diverse functions regarding different bioremediation products to be properly understood and well characterized, the information on which can then be readily accessed and used by multi-agency regulators, decision makers, and spill-response management structures. The lack of such will continue to act as a barrier to legitimate use of nontoxic remedies and, more importantly, continue the suboptimal course of inadequate response, denying relief to all fauna and flora exposed to industrial toxins.

We hereby submit this appeal to all stakeholders, **that urgent revisions must be made to the NCP in compliance with US laws.**

We invite industry professionals and decision makers at federal, state, and local levels tasked with updating their oil spill response capabilities to review material compiled by experts in the Bioremediation Technology sector, portions of which have been made available in this publication. We are confident that this engagement will result in identifying nontoxic solutions that comply with the Clean Water Act, resulting in coordinated response plans with a more certain end point of fully removed oil and contamination from the Gulf of Mexico and all US navigable waters.

According to the Operational Science Advisory Team report initiated by the US Coast Guard … "*The degree and rate of weathering of Deepwater Horizon oil is still uncertain.*" … Given the fractured and faulted condition of the seabed floor around Macondo Block 252, it is expected oil will continue releasing from this site for up to 10 years or more.



(Source: en.wikipedia.org/wiki/File:Oil_producing_countries_map.png)

All oil-producing countries should review their spill contingency plans and adopt clean cleanup solutions.

A Final Comment about Dispersants

Dispersants are building a negative reputation in many countries outside the United States, with an aggregate of studies indicating their use can cause enormous natural resource destruction.

This stance is reinforced by the 33-year tracking of the Ixtoc, *Valdez*, and other spills of significance, followed by the now unprecedented BP Deepwater Horizon spill wherein the President's Gulf Oil Spill Commission called for a critical review of the response, strongly advising a reappraisal and update of the US National Contingency Plan, with a better assessment of the efficacy of various dispersants and their associated "trade-offs." This review included a request for updated guidance on Bioremediation Agents. Legislation is also being proposed in light of concerning discoveries made over dispersant use.

In August 2012, a coalition of US public health, wildlife, and conservation organizations filed a Clean Water Act lawsuit naming the US Environmental Protection Agency (EPA) for failure to make available science-based information on the toxicity levels of dispersants listed on the NCP Product Schedule.[36] This failure allegedly resulted in faulty decision making during the 2010 Gulf spill.

The Clean Water Act specifically calls for oil spill response to *remove* oil from the environment. Dispersants have no means to do this.

Regulatory guidance unfortunately describes the use of dispersants in terms of "*being effective*" without defining what *effective* means. This phrase might imply a method that is successful in cleaning up a spill. However, cleaning up a spill (making the environment uncontaminated and removing the oil) is not the US EPA's definition in this situation. For a chemical dispersant to be included on the official NCP list (National Contingency Plan for oil spill disaster cleanup), the US EPA merely requires that the dispersant have an ability to sink 45 percent of the oil below the surface within 30 minutes after application.[37] This definition is not an acceptable standard for oil spill cleanup. It is, however, what is meant when the EPA describes dispersants as being "effective." The qualifications for being listed as a dispersant on the NCP Product Schedule do not include the capability of removing hydrocarbons from the environment; and as has been demonstrated, chemical dispersants do not have that capacity.

These concerns were aptly summarized by *The Nation*, citing a study conducted by Dr. J. H. Diaz published in the *American Journal of Disaster Medicine* in 2011.[38]

"Crude oil contains polycyclic aromatic hydrocarbons (PAHs), a group of more than 100 chemicals that are highly toxic and tend to persist in the environment for long periods. PAHs, some of which are human carcinogens, can bioaccumulate up the food chain (i.e., the toxins stored in the body of an organism are passed along when the body is consumed by a larger organism). Like VOCs, they target the skin, eyes, ears, nose, throat and lungs. But the EPA was not sampling for PAHs in the air until the very end of the spill."

Added to the oil was Corexit, "two types of which were used in the Gulf: Corexit 9527A and 9500. The first type contains 2-BTE (2-butoxyethanol), a toxic solvent that can injure red blood cells (hemolysis), the kidneys and the liver. The CDC has reported chronic and acute health hazards associated with it. Corexit 9500 contains propylene glycol, which can be toxic to people and is a known animal carcinogen. Both can bioaccumulate up the food chain. Toxipedia Consulting Services, a moderated wiki run by the Institute of Neurotoxicology and Neurological Disorders, has found 'reports among Gulf residents and cleanup workers of breathing problems, coughing, headaches, memory loss, fatigue, rashes, and gastrointestinal problems [that] match the symptoms of blood toxicity, neurotoxicity, adverse effects on the nervous and respiratory system, and skin irritation associated with exposure to the chemicals found in Corexit.'"

Conclusions and Findings

One of the largest and most bounteous interdependent life systems in the world, the Gulf of Mexico, has been devastated by the Deepwater Horizon disaster. The response required was greater than what had been prepared for, and the agencies of response were not equipped with strategies to adequately address it—constrained by adherence to outdated guidance that advocates the use of dispersants as a preapproved cleanup method, thus effectively hampering decision makers (OSCs) from having any other options for the selection of alternative and more workable solutions.

The past is behind and errors can be forgiven if action is taken by government and private sectors to implement nontoxic solutions in oil spill remediation.

Renowned international conservationist and author Dr. Lawrence Anthony, founder of the Lawrence Anthony Earth Organization, had a reputation for bold conservation initiatives, including the rescue of the Baghdad Zoo at the height of the 2003 US-led coalition invasion of Iraq, and negotiations in South Sudan with the infamous Lord's Resistance Army to increase understanding of the environment and protect endangered species, among them the last of the northern white rhinoceros. Anthony dedicated his life to raising awareness of how finite, vulnerable, and interconnected Earth's integrated systems of plant and animal life are. LAEO's science-based mission is to work with governments, industry, and the broad public to stably reverse decaying environmental and conservation situations. We have coined a new phrase to describe the philosophy upon which we work: *Cooperative Ecology.*

The response required was greater than what had been prepared for, and the agencies of response were … constrained by adherence to outdated guidance that advocates the use of dispersants as a preapproved cleanup method, thus effectively hampering decision makers (OSCs) from having any other options for the selection of alternative and more workable solutions.

Cooperative Ecology (CoEco) (*noun*) is defined as the study of the mutual interdependency and cooperation of all life forms and the material world. It is based on the premise that all life forms are interdependent and engaged upon the same objective—to survive—and are acting in mutual support of this objective for their joint perpetuation. The moment life forms, including man, fall away from the concept of mutual cooperation with all other life forms and the material world, their capability to survive diminishes and becomes less effective. CoEco includes the study of man's sciences in the light of this cooperative relationship of all life forms, and it determines the value of sciences on these principles. Whether sciences bring about a steady improvement for life forms and the material world or whether they create imbalances determines to what degree the sciences themselves are cooperating with life and, thereby, their relative value. The study includes, as well, ecological and economic policy and their impacts based on these principles. It is holistic, by necessity, and requires the interaction with, and study of, 1) the full spectrum of scientific methods and views; 2) all life forms and their interrelationships; 3) micro- to macroeconomic and governmental policies; 4) religious influence; and 5) population systems. And it must, inevitably, study the interrelationships of each of the above points as they influence the environment.

The objective of Cooperative Ecology is to generate improved science and policy that increases the survival potential and productivity for all interdependent life to a level of balanced abundance, guaranteeing mutual perpetuity.

As it is fundamental to all life, clean water will be the gold of the future. LAEO is dedicated to cleaning up the polluted waters of the world by identifying and authenticating effective nontoxic cleanup technologies and getting these officially designated for use and applied. It is not enough to add nontoxic solutions to current methods; long-term survival requires retiring the offending agents, whether these be domestic or industrial wastewater treatments or dispersants.

Had government and BP officials been aligned in an intent to use nontoxic means—which current technologies provide—to remove all possible oil from the Gulf waters, it would have saved BP billions of dollars and averted disastrous public-health consequences and damage to natural resources.

A significant stumbling block to real change is the resistance to admitting that dispersants are not the best solution. Our Gulf of Mexico states were forced to take this known poison pill, which destroys natural resources and spreads the adverse impact of a spill to the water column, seabed, shoreline, and beyond (now proven by scientists who found Corexit in 80 percent of the pelican eggs tested on a migratory destination island in a Minnesota lake, all attributed to the use of Corexit on the DWH spill[39]).

The EPA / federal government knows the consequences of the use of Corexit and similar dispersants, such as the discontinued Inipol, just as they know full well what happened and what continue to be the aftereffects of these same chemicals employed in response to the 1989 *Exxon Valdez* spill in Alaska.

LAEO is working to educate key decision makers and all interagency response network members about current available nontoxic methods of oil spill cleanup. As of the writing of this position paper, OSE II is the only approved product on the NCP list that meets our required guidelines; therefore, OSE II is the first product to garner full support from the LAEO. We invite submissions of other products and look forward to being able to support additional nontoxic, effective, and swift methods of oil spill cleanup.

The objective of Cooperative Ecology is to generate improved science and policy that increases the survival potential and productivity for all interdependent life to a level of balanced abundance, guaranteeing mutual perpetuity.

Herewith is our call to action related to oil spill cleanup:

A Call for Change in Oil Spill Response

- Ban the use of toxic chemical dispersants, or any other scientifically identified toxic agent used for oil spill "cleanup," in US navigable waters and all environments.

- Revise and correct the National Contingency Plan and all related guidance documents referenced by Regional and Area Response Teams to reflect current science and information, specifically including

    » the immediate withdrawal of the EPA's *preapproval* (blanket authorization) for the use of dispersants in US navigable waters as part of the National Contingency Plan;

    » correction of all material guiding the use of Bioremediation Agents, to remove the misinformation and to list EA Type as a first-response nontoxic option;

    » add the article *BIOREMEDIATION TECHNIQUES, CATEGORY DEFINITIONS, AND MODES OF ACTION IN MARINE AND FRESHWATER ENVIRONMENTS* to the NRT, RRT, NOAA, and Coast Guard published bioremediation materials to reeducate all team members on the corrected science concerning bioremediation.

- Exert pressure on the US EPA to issue the necessary authorization for nontoxic bioremediation methods already screened by EPA scientists and approved (Bioremediation Agent Type EA, OSE II) to be deployed immediately to bring the Gulf waters and associated environments back to good health.

- Raise pollution removal standards up to the original intent of the Clean Water Act by requiring all companies that have the potential through their working processes of creating oil spills to include NCP-listed products that are nontoxic in their cleanup protocols, ensuring their plans employ methods that swiftly and completely remove oil from a spill area.

If you find this to be a worthwhile message and purpose, please help us by passing it on to others. Your help and support is welcome and appreciated.

Respectfully submitted by the
Lawrence Anthony Earth Organization, Science & Technology Advisory Board

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27. The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan or NCP, is the federal government's blueprint for responding to both oil spills and hazardous-substance releases. Full text at http://www.epa.gov/oem/lawsregs.htm#ncp.

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29. In the recent toxicity studies of dispersed oil, most researchers found that chemically dispersed oil was more toxic than physically dispersed oil, and biodegradation is not supported by the use of chemical dispersants. M. Fingas, Spill Science, Edmonton, Alberta, PWSRCAC, Anchorage, Alaska, *A Review of Literature Related to Oil Spill Dispersants 1997–2008*, http://oilfreefuture.org/Dispersant/literature_review.pdf.

30. J. W. Tunnell, Jr., Texas A&M University, *An expert opinion of when the Gulf of Mexico will return to pre-spill harvest status following the BP Deepwater Horizon MC252 oil spill* (January 31, 2011), http://media.nola.com/2010_gulf_oil_spill/other/Tunnell-GCCF-Final-Report.pdf.

31. Robert Barham, Secretary of the Louisiana Department of Wildlife and Fisheries, http://www.nola.com/sports/index.ssf/2012/09/hurricane_isaac_showed_that_bp.html; "History's 10 Most Famous Oil Spills," https://sites.google.com/site/ubuwoil/history-s-10-most-famous-oil-spills.

32. *Hidden Crisis in the Gulf* documentary, http://earthorganization.com/News.aspx?tid=108.

33. Jong Nam Kim et al., "Effects of Crude Oil, Dispersant, and Oil-Dispersant Mixtures on Human Fecal Microbiota in an In Vitro Culture System," mBio (2012), 3(5):e00376-12, doi:10.1128/mBio.00376-12. "Dispersed oil affected the intestinal microbiota more than either oil or dispersant alone. This may be due to the increased solubility of dispersed oil, which could provide more surface area of hydrophobic and toxic compounds for microbial contact than oil alone. Therefore, dispersed oil may be more bioavailable to the microbiota than oil alone. Previous studies reported that chemical dispersants may increase the concentration of PAHs in the water column. The toxicity of dispersed oil showed that chemically dispersed oil increased the toxicity and concentrations of TPHs and PAHs in fish more than mechanically dispersed oil, dispersant alone, water-soluble oil fractions, or seawater alone."

34. Sample Toxicity Comparison LC 50 Values on chart can be found at EPA/BP Tests, http://www.epa.gov/bpspill/reports/ComparativeToxTest.Final.6.30.10.pdf; Environment Canada Reports, http://www.etc-cte.ec.gc.ca/databases/SpillTox/Default.aspx.

35. *OSEI Corporation Summary of the US EPA Regional Response Team VII Testing of OSE II on Heavy Waste Oil, February 1 to March 8, 2012*, http://www.osei.us/pdf%20files/RRT%20plus%20testing.pdf; Oil Spill Cleanup Demonstration on Arabian Gulf, http://osei.us/archives/1135.

36. Case 1:12-cv-01299, Document 1, filed 08/06/12, http://www.akaction.org/Just_the_Facts/Press_Releases/2012-08-06_EPA_Dispersants_Complaint.pdf.

37. 40 CFR, Part 300, Appendix C, 2.5, numbers 5, 6, and 7, describes the 20-minute time test on the shaker table, then 10 minutes of settling, for a total of 30 minutes, to allow the oil to sink. This section of 40 CFR is where the EPA derived its statement regarding the test of dispersant "effectiveness."

38. *The Nation* (May 7, 2012), http://www.thenation.com/article/167461/investigation-two-years-after-bp-spill-hidden-health-crisis-festers; J. H. Diaz, "The legacy of the Gulf oil spill: Analyzing acute public health effects and predicting chronic ones in Louisiana," *American Journal of Disaster Medicine* 6, no. 1 (January/February 2011): 5–22, doi:10.5055/ajdm.2011.0040.

39. Minnesota Department of Natural Resources report, *MPR News* (May 16, 2012): "Petroleum compounds were present in 90 percent of the first batch of eggs tested. Nearly 80 percent of the eggs contained the chemical dispersant used in the Gulf," http://minnesota.publicradio.org/display/web/2012/05/16/environment/oil-residue-found-on-pelicans.

GLOSSARY

biocatalyst. A substance, such as an enzyme, that starts or increases a chemical reaction in a living body.

biocide. Any toxic chemical that has the potential of destroying life forms by poisoning.

biodegradable. Capable of being decomposed into nontoxic components by bacteria or other living organisms.

biodegradation. The process that microbial organisms use, through metabolic or enzymatic action, to break down toxins into their nontoxic components.

bioremediation. Utilization of the metabolic and enzymatic processes of microorganisms to remove pollutants from the environment.

biosurfactants. Substances produced by microorganisms that lower the surface tension of water and increase the ability of organic compounds, like crude oil, to more easily dissolve in water, thereby making them more available for microbial degradation. (See also *surfactant*.)

carcinogen. A substance that is capable of causing cancer in humans or animals.

***Clean Water Act* (*CWA*)**. The Clean Water Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972. Source: http://www.epa.gov/lawsregs/laws/cwa.html.

Corexit. A line of solvent products licensed by Exxon to Nalco Holding Company for production and distribution. They are primarily used as dispersants for breaking up oil slicks and sinking the oil out of sight below the surface waters. Corexit was used as the primary dispersant in the British Petroleum Deepwater Horizon oil blowout in the Gulf of Mexico. It causes the oil to break up into small globules that remain suspended in the water, eventually sinking to the seabed and then ultimately washing up on beaches as currents and storms churn the oil up off the seabed and from the water column. See "NALCO Corexit and Crude Oil: A Laboratory Experiment," http://www.bust-video.info/v/yt:BdAtvB9OtRs/1.

Deepwater Horizon. An offshore oil drilling rig owned by the Transocean corporation and leased to British Petroleum. On April 20, 2010, during drilling in a geographical area of the Gulf of Mexico called the Macondo Prospect, a blowout killed 11 crewmen. Two days later, after a second explosion, the rig sank, leaving at least one well and a crater in the seabed floor gushing oil uncontrollably, causing the largest offshore oil spill disaster in US history.

detergent. A surfactant or a mixture of surfactants that facilitate the mixing of compounds like oil and grease with water, normally used for cleaning purposes.

dispersant. A liquid or gas added to a mixture such as oil in order to promote dispersion of the oil or to maintain suspension of the dispersed oil particles.

DOSS (***dioctyl sodium sulfosuccinate***). A toxic surfactant that is a component of Corexit. Common side effects of exposure to DOSS include a breakdown of the cellular walls of red blood cells and subsequent rectal bleeding, stomach pain, diarrhea, serious allergic reactions, and cramping.

ecosystem. Short for ecological system. The symbiotic relationships between all living organisms in a particular geographical area and the nonliving components of their environment, such as air, water, and soil. These organisms and components operate together through nutrient cycles and energy flows.

emulsification. The resulting blended mixture of two or more liquids that are normally not able to be mixed or blended, such as oil and water. In an emulsion, the particles of one liquid are dispersed in the other, rather than dissolved.

Environmental Protection Agency (***EPA***). A US federal government agency whose mission statement is to protect the health of the public and the environment by writing and enforcing regulations based on laws passed by Congress. Led by a senior administrator appointed by the US president and approved by Congress, the EPA, although not a cabinet department, is directly under the president and is responsible for fulfilling the president's constitutional mandate to protect and defend the natural resources of the US.

enzymes. Biological molecules that increase the rate of chemical reactions. They are responsible for the thousands of chemical interconversions that sustain life.

federal On-Scene Coordinator (***OSC***). See On-Scene Coordinators.

finishing-up product. A term used to describe an oil spill cleanup product that cannot successfully address fresh oil because of the oil's high level of toxicity.

fishery. An ecosystem in a particular geographic area of water or seabed, which includes the people involved, method of fishing, class of fishing boats, one or more species or type of fish, including shellfish, and the purpose of the activities—i.e., recreational or commercial.

genetic. Pertaining to the heredity of traits.

hydrocarbons. Organic compounds made up solely of hydrogen and carbon. The majority of hydrocarbons that exist naturally occur in crude oil and are toxic and often carcinogenic.

indigenous. A description of a living organism (plant or animal) that is native to a specific geographical region.

insoluble. Incapable of being dissolved in water or another liquid.

Ixtoc I. An exploratory oil well being drilled by the semisubmersible drilling rig Sedco 135-F in the Bay of Campeche of the Gulf of Mexico, about 100 km (62 mi) northwest of Ciudad del Carmen, Campeche, in waters 50 m (160 ft) deep. On June 3, 1979, the well suffered a blowout resulting in one of the largest oil spills in history.

Lawrence Anthony Earth Organization (***LAEO***). An environmental and conservation nonprofit founded in 2003 by South African conservationist, author, and humanitarian Lawrence Anthony. As of this writing, the organization has 23 chapters in 21 countries. Since the beginning of the Deepwater Horizon oil blowout, the US chapter has focused on finding and getting implemented workable solutions that will result in returning the Gulf of Mexico's contaminated waters to their pre-blowout condition, as a part of the organization's larger campaign to return polluted waters of the world to their pristine condition. The LAEO's mission is to work with governments, industry, and the broad public to stably reverse decaying environmental and conservation situations through education and hands-on projects. Among their many accomplishments, they have created two large game reserves in South Africa, reopening migration corridors for the wildlife and aiding local tribes in transferring from poaching to eco-tourism as an economic base. Three books have been written about Lawrence Anthony's achievements—*Babylon's Ark*, *The Elephant Whisperer*, and *The Last Rhinos*—and a Hollywood feature film is being produced about his life. LAEO coined a new term, *Cooperative Ecology,* to clearly define the philosophical basis upon which the organization operates. Commonly shortened to "Co-Eco," the term is defined fully on pages 27–28 of this document.

lyse. To cause dissolution or destruction of cells by lysins.

lysins. Antibodies or other agents that cause red blood cells or bacterial cells to break down.

Macondo. The Macondo Prospect (Mississippi Canyon Block 252, abbreviated MC252) is a geographic area in the Gulf of Mexico off the coast of Louisiana containing a massive geological trap for oil and gas. It was the site of the British Petroleum Deepwater Horizon oil blowout disaster of April 20, 2010.

mechanical cleanup. Generally, in oil spill cleanup, this is the use of booms to try to contain oil or keep it away from sensitive areas, and skimmers designed to skim as much of the oil off the surface as possible. *In situ* burning of the oil is also a common method, but this is potentially hazardous to human health.

metabolism. The chemical processes occurring in living organisms that result in growth of the organism, production of energy, elimination of waste, and other basic organic functions. —v. *metabolize*.

microbe, microorganism. Any living organism too small to be seen without the use of a microscope.

microbiological. Having to do with the structure, function, uses, and modes of existence of microscopic organisms.

miscible. Applies to liquids: capable of mixing together completely to form a solution.

mutagenic. Capable of causing or increasing the rate of unnatural mutations in living organisms.

mutation. An unnatural change within the structure of a living organism caused by exposure to a mutagenic toxin.

***National Contingency Plan* (*NCP*)**. The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan or NCP, is a government document delineating required response protocols and methods in circumstances where oil and hazardous substances have been released into the environment.

NCP Product Schedule. Subpart J of the National Contingency Plan is a Product Schedule that contains dispersants and other chemical or biological products that have gone through the EPA's testing requirements to be considered for use in carrying out the NCP when oil or other hazardous substances have been spilled. Being on the NCP list does not give automatic approval status for the various products that are listed on the Product Schedule. Each time an oil or hazardous substance spill occurs on US navigable waters, approval for which product(s) can be utilized on that specific spill must be obtained by Regional Response Teams and Area Committees, or by the federal OSC, in consultation with EPA representatives. It is interesting to note that, in the past 23 years, the only product that has ever been approved for use when an actual oil spill on US navigable waters has occurred is Exxon's product line called Corexit, despite the existence of other products on the NCP list that are less expensive, more effective, and have fewer damaging side effects.

nutrients. As used in this paper, these include carbon, nitrogen, and phosphorous as well as vitamins, which form the building blocks needed to grow microorganisms.

***On-Scene Coordinators* (*OSCs*)**. Federal officials predesignated by the US EPA and Coast Guard to coordinate response resources in disaster situations. Under the National Contingency Plan, if federal involvement is necessary because state and local resources have been exceeded, the OSC is obligated to coordinate the use of these resources to protect public health and the environment.

PAH. Polycyclic aromatic hydrocarbon, a molecule made up of hydrogen and carbon, with multiple carbon rings. PAHs are persistent, bioaccumulative, and toxic pollutants, which include many carcinogenic substances and environmental toxins.

plankton. Tiny organisms occurring in a body of water, primarily comprising microscopic algae and protozoa.

pollutants. Toxins that contaminate water, soil, and air.

***Regional Response Team* (*RRT*)**. Regional planning and coordination of preparedness and response actions for disasters are accomplished through the RRT. There are 13 RRTs, one for each of ten federal regions, plus one for Alaska, one for the Caribbean, and one for the Pacific Basin. Each RRT maintains a Regional Contingency Plan (RCP) and has state, as well as federal government, representation. EPA and the Coast Guard co-chair the RRTs. Standing RRTs are planning, policy, and coordinating bodies and do not respond directly to disaster scenes. The RRT provides assistance as requested by the On-Scene Coordinator during an incident. Source: http://www.rrt.nrt.org/.

solubility. The relative ability of a substance to be dissolved in water or other liquid.

solubilization. The action of dissolving in a liquid.

solvent. A substance that has the capacity to dissolve another substance.

surfactant. A substance that lowers the surface tension of water, making it easier for organic compounds to be dissolved in the water. Detergents are an example of surfactants, as they help remove organic compounds from a given material by making them dissolve more readily in the water in which the material is washed. Both toxic man-made surfactants and nontoxic natural surfactants exist.

teratogenic. Capable of causing birth defects and negatively impacting the development of a fetus.

toxin. Any substance that is poisonous to live organisms.

***volatile organic compounds* (*VOCs*)**. Organic chemicals that have a high vapor pressure at ordinary room-temperature conditions. VOCs are numerous, varied, and present everywhere. They include both human-made and naturally occurring chemical compounds. Harmful VOCs are typically not acutely toxic, but instead have compounding long-term health effects.